

ADAPTIVE FINITE ELEMENT SIMULATION OF ELASTIC WAVE PROPAGATION WITH CHARMS

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Detection of flaws such as voids or cracks in railroad tracks is a practically important issue that is at the center of health monitoring efforts currently under development by Professor Lanza de Scalea at the UCSD. The approach is based on an active excitation of guided sound waves in the rail followed by intelligent processing and interpretation of the received signal. Simulation of the propagation of the elastic waves through the rail is an important component of such an approach in that it allows to determine the signatures of the waves created by the flaws that scatter the elastic wave between the excitation point and the sensor. Many finite element simulations need to be run: hence the need for adaptive discretization that concentrates computing effort to where the error may be reduced most profitably.

The present contribution describes an adaptive framework that is being developed to address propagation of elastic waves in arbitrary geometries: hexahedral and tetrahedral [3] meshes are supported, and extensions to other types of discretization have also been successful [2]. The basis of this framework is the CHARMS (Conforming and Hierarchical Adaptive Refinement MethodS) adaptive refinement methodology [1], which is geared towards simulations with approximation basis functions constructed on finite element meshes of arbitrary element type and approximation order. At the foundation of CHARMS is the multi-resolution equation, providing CHARMS with generality, robustness, and ease of implementation that exceed the capabilities of current technology.

Publications, examples of simulations, and pointers to other information are available at [4].

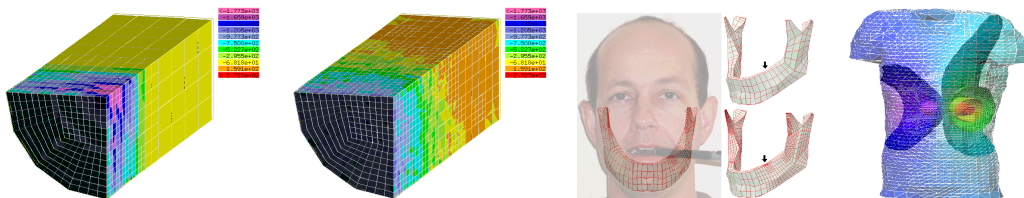


Figure 1: Examples: Impact generated pressure wave in an inhomogeneous rod; Adaptive stress analysis of mandible; Poisson equation solved on a tetrahedral mesh of the human torso.

References

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- [2] E. Grinspun, P. Krysl, and P. Schröder. CHARMS: A simple framework for adaptive simulation. *ACM Transactions on Graphics*, 21 (3): 281-290 JUL 2002, 2002.
- [3] L. Endres, P. Krysl. Refinement of Finite Element Approximations on Tetrahedral Meshes with Guaranteed Shape Quality *International Journal for Numerical Methods in Engineering*, 2003. submitted.
- [4] P. Krysl. <http://hogwarts.ucsd.edu/~pkrysl/charms.html>